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# ON<sup>4</sup> SIGHT,

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## AND ITS RELATION TO INVERTED IMAGES,

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*And lately of Her Majesty's 83rd & 93rd Highlanders.*



"The advances made in the knowledge of optics, in the last age and the present, and chiefly the discoveries of Sir Isaac Newton, do honor, not to philosophy only, but to human nature. Such discoveries ought for ever to put to shame the ignoble attempts of our modern seepies, to depreciate the human understanding, and to spirit men in the search of truth, by representing the human faculties as fit for nothing but to lead us into absurdities, and contractions."—*Reid on the mind.*

As the object of the following paper is to show how erect images are produced, and as its subject cannot fail to be extensively criticised by the most enlightened of the general public, and by many of the best learned of my medical brethren; little of the anatomy of the eye need be recapitulated here, so as to make the subject as concise and simple as possible.

It is known to every well-informed person that the eye of man and quadrupeds, though differing in some points, are formed upon the same dioptric principles, and with the same objects in view, viz: to act as a system of lenses to convey light and outward luminous impressions (through these) to the brain.

To simplify the matter as much as possible, it would be better to state before proceeding further that I receive as axioms in the future marks, 1st. That rays proceeding from a rarer to a denser medium are drawn towards the perpendicular. 2nd. *Vice versa* to the first. 3rd. That the denser the medium may be, the sooner will the rays be brought to the perpendicular.

Thus rays proceeding from any outer body in the air, on arriving and passing through the aqueous humour, crystalline lens, and vitreous humour, as they are all of greater densities than the atmospheric air are drawn to the perpendicular.

By a peculiar construction about the eye of man and of quadrupeds can be made more or less convex, and thus adapted to greater or less distances. The presence also of a movable diaphragm, regulates the admission of light, and by these two properties it will become apparent, on a little consideration that the object painted on the anterior surface of the retina may become larger or smaller. In the normal condition of the organ, such does actually take place, as easily may be seen on exposing the eye to a dimmer or brighter light. But as we go down the scale of animated creation, we find no such contrivances, still we see a simpler but no less admirable adaptation means to an end.

It has all along been a bugbear and stumbling block to philosophers why an inverted image (as seemed to them) should be depicted on the retina, and thus conveyed to the brain, and which they

attempted to prove in the following manner,—“after taking the eye of an ox, and leaving the vitreous humour perfect, they took a piece of white paper or other transparent material and with it covered the posterior part of the eye, thus placing it in the position of the retina, when on opposing the convex surface of the cornea to some outward object, the image of the same appeared on the coating behind, but inverted.” Having seen this, they came to the conclusion that such would require to be the case with the human eye, and the impression it left on the brain, and strange to say, every one had powerful arguments to support his own opinion.

Amongst the leaders of this theory were some of the most celebrated men of their day, and as ever happens, many took it as a received truth; allowing their mental powers to lie dormant and desisting from any research though at the same time, the minute physiological and chemical structures of the organ were well known.

By taking either a double convex or plano convex lens and placing before it an object, it will, after passing through such a medium fall towards the perpendicular, and if allowed to proceed far enough after passing through the lens, the rays will again diverge, but this time the upper ones of the original figure will be downwards and the lower ones upwards, and according as the distance is nearer or further removed from the lens after forming this image, its appearance will be smaller or greater.

Such actually does take place within the the eye of man and domestic animals, and the experiment on the bullock's eye is essentially correct after giving allowance for the change of shape of the organ, and immobility of the iris—

Yet, though the artificial retina will receive an impression, it is far from being a true one of the complete process which reaches the brain, and this as will be seen accounts for the errors which happened.

The best anatomists of the day are agreed that the retina consists of three parts, viz.: an outer membrane called Jacobs, which consists of little piles stuck at right angles into the retina and though the use of these cannot be actually arrived at, they seem to act somewhat as a discharging battery, when vision is required to be more intent, by pressing more firmly upon the anterior and more inner parts by the blood-vessels of the choroid been more fully injected. Yet they don't seem to be more immediately concerned in vision, but to be loosely connected with the parts which lie next them, and are actually those most concerned in the process. These consist of an external and an internal layer of nerve cells, with an intermediate layer of fibres, still between these and the vitreous humour, lies a delicate net work of arteries and veins, held together by cellular membrane, through which vision must pass before it reaches the brain.

On this delicate curtain the inverted image is depicted, but it is to be remembered that in the state of health the eye can be both fitted for distance and exclude nearly all, but the number of rays required for perfect vision, so that the size, brightness, and distance of an object, are properties which require some instruction before being appreciated. The rays which are actually required for vision, fall

on a limited spot, yet when they fall on this delicate curtain, the object is inverted, but the anterior or inner layer of nerve cells soon bring them beyond the perpendicular again, so that before they arrive at the fibres which lie between the two rows of cells, the image is really erect. Such a conclusion would not be doubted by any one, if there were really only one of these cells, and that the inverted image really fell on its anterior surface, but because there are so many of these, many would prefer to stick to the old opinion, not discerning that the multitude of these cells really make the image more certainly perfect, at whatever angle any outward ray may reach the eye, and that it mattered not, whether or not there was a curtain to receive it. Were it not so, let us reason the matter and see what the consequence would be, if the image was erect, when it fell on this curtain, and we will find that after it had passed through these anterior cells it would, instead of giving an erect image to the brain give an inverted one, as we must recollect, that though these small bodies measure after death scarcely  $\frac{1}{300}$ th part of an inch in diameter, and probably, though full not much larger during life, yet though they were much smaller, they are actually translucent, double convex, and of a greater density than the vitreous humour. Under such circumstances, having minute radii, they are capable not only of acting as lenses, but as very powerful ones, in bringing the inverted image rapidly into an erect position, even before arriving at the fibres which separate these anterior from the posterior cells. It may not moreover be too much to infer that the fibres which separate the two rows of cells, if they do not convey the sensation of sight through their own instrumentality, act as in secreting glands, the part of a basement membrane, and allow the peculiar requisite for sight to pass through to be absorbed by the posterior layer, and by them to be carried to the brain.

The common fire wheel of the school boy, seems also a physiological proof, that these small cells, do individually carry the sensation of images to the brain, for in this though it actually appears to the eye to be a continuous sheet of flame, is nothing but a red point whirled rapidly round in the air, from which rays pass as quickly first to one of these cells and then to another, thus keeping up the illusion. Other instances of the same kind are found in those parti-coloured deceptions seen in some drawing rooms, as also in our common kaleidescopes.

When one looks at the eye of the fly, we see there a number of little conical projections, which though on the surface of that insect, somewhat resembles these small cells, and which must undoubtedly answer the same purpose, but be in them a complete optical apparatus. Yet still though there be so many we have no reason to think that they convey to the sensorium a number of images but a single one.

Such a wonderful system of double convex lenses formed by the anterior portion of the optic nerve, not only would individually correct the inverted image, but if one set failed, others would supply the deficiency, as in all probability they do in the fly. It is for the same reason that in a dim light the pupils expand to allow more rays to fall on the retina, making a larger image to be formed on its delicate screen, and a larger number of these small bodies to act upon it,



thus supplying the deficiency which a brighter light would obviate; moreover, it is in all probability owing to this screen or the anterior cells, becoming opaque, that sight is destroyed in many ophthalmic diseases, when the larger lenses are perfect, thus giving that peculiar appearance which is seen in man when suffering from glaucoma, or in the sheep when suffering from rot. Notwithstanding all this, though we are struck with the admirable arrangements we find in the minute insects, we have not time to stoop to investigate closely enough such a system in our own complicated machinery.

Some will say that these which I make such a work about, are only nerve cells, yet without questioning the truth of the assertion I add that as such are found there, and in the axis of vision, they serve the purpose of double convex lenses, and that although they are placed in the aggregate as a concavo convex lens, it is only another proof of the wisdom of our Creator.

When we speak of an image being formed upon the retina, we are all agreed that it is produced by rays of light, though it must be remembered that the number which comes from different bodies differ very much, yet when they strike the eye, a larger or smaller inverted image is formed behind the vitreous humour, from which each of these cells takes up for itself a distinct image, and after having resolved it into the erect position, presents it correctly to the brain. To prove that such is actually the case, if behind the translucent screen which was used in the experiment of the bullock's eye a few small glass beads be placed and properly adjusted, you will see in any of them an erect and not inverted image.

Were it not so, on the same principle it might be said that only one party could see the sun, because its rays struck his eye, yet they struck also the eyes of another in like manner. From this it appears that our eyes as those of our domestic animals differ very little from that of the fly, than in having an optical mechanism prefixed to the real sentient parts, for preparing and allowing only a certain number of rays to fall on the most delicate requisite.

In each eye these small cells have a corresponding one in the other, which are doubtless connected by fibres with each other, which run from one eye to the other, and explain the reason why two images are seen in one and the same object, when one of the eyes is kept in the usual axis, and the other pushed out of it.

Upon a little reflection it seems strange how human understanding could be so warped as to believe for an instant, such reasoning as tended to convince them, that they really saw every thing upside down, and that it was only by their being accustomed to such cases from childhood that they referred them at once to their real cause and knew their proper position.

I will dilate no further on the subject; yet not leave it without remarking on the absurdity put forward by a very celebrated man, viz.: that vision would be better performed by one than by two eyes, when we see with what care so much surface is exposed in the least possible space in every important part of the animal economy, becoming less and less so as we descend in the scale of animated creation.